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FLOOD INSURANCE STUDY

ORIGINAL

CITY OF MADERA, CALIFORNIA

MADERA COUNTY

VOLUME 1 OF 1

Federal Emergency Management Agency

COMMUNITY NUMBER - 060172

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NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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FLOOD INSURANCE STUDY
CITY OF MADERA, MADERA COUNTY, CALIFORNIA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Madera, Madera County, California and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Gill & Pulver Engineers, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-84-C-1637. This study was completed in August 1985.

1.3 Coordination

Streams requiring detailed study were identified at an initial Consultation and Coordination Officer (CCO) meeting attended by representatives of the study contractor, FEMA, and City of Madera in April 1984.

Results of the hydrologic analyses for streams studied by detailed methods were coordinated with the U.S. Army Corps of Engineers (COE), Sacramento District and the City of Madera. On July 10, 1984, the City of Madera was contacted to obtain all available existing data for the study. The Sacramento District of the COE and Madera County Irrigation District were contacted regarding the question of Hidden Dam and the downstream diversions.

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On December 2, 1985, the results of the study were reviewed at a meeting attended by representatives of the study contractor, FEMA, and the community. The study was acceptable to the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated areas of the City of Madera, Madera County, California. The area of study is shown on the Vicinity Map (Figure 1).

The Fresno River was studied by detailed methods in the community from the downstream corporate limits just below State Route 99 South to the upstream corporate limits below Tozer Street. These areas were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through June 1988.

2.2 Community Description

Madera is located about midway and toward the eastern edge of the San Joaquin Valley, which is oriented northwest to southeast and has a length of about 225 miles and an average width of about 50 miles. The Fresno River flows east to west through the City. The terrain around Madera itself is generally level with an abrupt upward slope about 10 miles eastward to the foothills of the Sierra Nevadas. The main Sierra Nevada Range is located about 50 miles to the east and extends from 12,000 to more than 14,000 feet in elevation. About 30 miles west of Madera lie the foothills of the Coastal Range.

The City of Madera had its beginnings with William Thurman, a lumberman, in 1875 when the area was still part of Fresno County. A V-shaped water flume, 54 miles in length, carried lumber from the high country to Madera by gravity flow. The railhead and later Highway 99 marked Madera for its place of importance in the San Joaquin Valley. Madera was chartered as an incorporated City, March 27, 1907, and is the County Seat of Madera County. It has industrial parks, recreational parks, food and meat processing plants, wineries, and agricultural excellence in diversified farming--all of which contribute to a solid and substantial economy. The population of the City of Madera in 1940 was 6,457 and had reached 16,044 by 1970. According to the Population Research Division of the State of California Department of Finance, the population of the City of Madera as of January 1985 was 29,950 (Reference 1). The City has experienced a growth of approximately 39% during the past decade.

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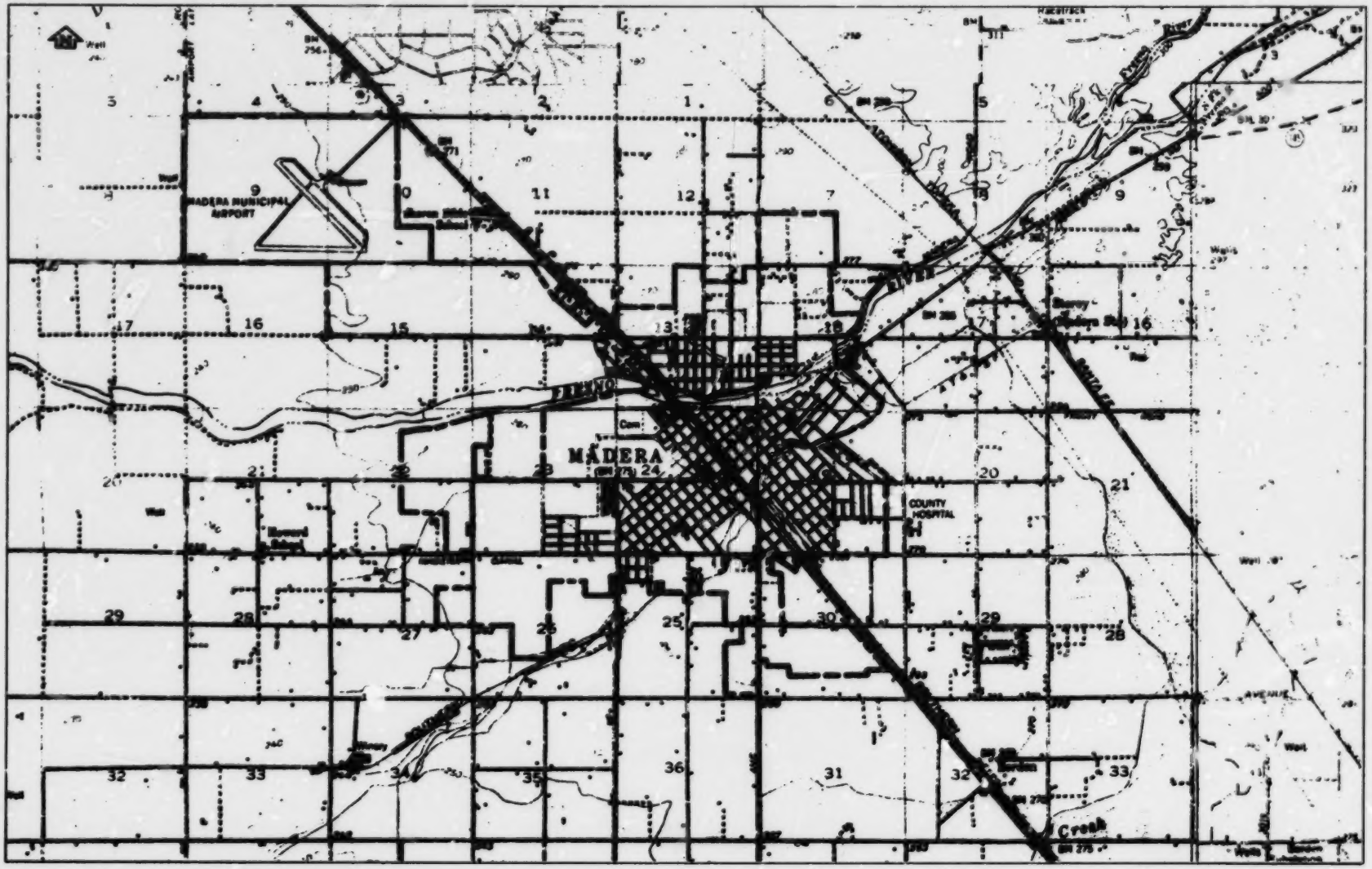

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MADERA, CA
(MADERA CO.)

APPROXIMATE SCALE

1 0 1 2 3 MILES

VICINITY MAP

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The climate of Madera is dry, mild in winter and hot in summer; nearly nine-tenths of the year's precipitation falls in the six months from November to April. Humidity is commonly as low as 15 percent and has been recorded as low as 8 percent. In contrast, humidity readings may reach 90 percent during the morning hours of December and January. The normal daily maximum temperature advances to a high of 99 degrees during the latter part of July. The daily maximum temperature during the warmest month has ranged from 76 degrees to 115 degrees. Winter temperatures are usually mild but during infrequent cold spells minimum readings occasionally drop below freezing. Heavy frost occurs almost ever year, and the first heavy frost in the autumn usually occurs during the last week of November. The last frost in the spring is in early March.

Winds flow with the major axis of the San Joaquin Valley; as the Valley is oriented from the northwest to southwest, the winds are generally from one of these directions with northwest prevailing most of the time. During the warmest months, the northwest winds increase during the evenings as a result of heating or thermal effects that have occurred during the day. These breezes and the normally large temperature variation of about 35 degrees between the highest and lowest readings of the day result in comfortable evening and night temperatures.

In addition to the Fresno River, there are numerous Madera Irrigation District canals in the immediate urban area. The entire county generally has excellent drainage. The eastern side of the San Joaquin Valley is a series of overlapping alluvial fans, each with a large mass of coarse, permeable deposits spread outward beneath the valley floor from the point where the stream leaves the foothills. These alluvial fans are deposits of well sorted sand and gravel which were deposited outside the major stream channels on the alluvial plain. The areas between the major alluvial fans are characterized by poorly sorted, fine grained sands and gravels that were deposited by creeks between major streams. The City of Madera is situated on a young alluvial fan with permeable to moderately permeable soil.

The California Department of Transportation, the Fresno Metropolitan Flood Control District and other agencies in the valley have for a number of years been developing ponding basins to dispose of storm drainage water. This program has the dual attraction of providing a means to conserve badly needed water, while at the same time disposing of storm drainage (Reference 2).

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2.3 Principal Flood Problems

The Madera area is known to have experienced many floods in the past. Historical data available indicate that floods occurred in the study area in 1861-62, 1867-68, 1911, and 1914. Records show that floods occurred in 11 of the past 38 years prior to the construction of Hidden Dam in September of 1976. Flooding occurred in 1938, 1943, 1945, 1950, 1952, 1955, 1956, 1958, 1962, 1963, and 1969. Since the operation of Hidden Dam in September of 1976, no floods have occurred in the study area.

The floods that occurred in December 1955 and February 1969 were of about equal magnitude and the most severe known in the study area. During the January 1969 storm, the levee system at the head of Cottonwood Creek overflow channel was overtopped and floodwater from Fresno River spilled into Cottonwood Creek at the rate of about 1,000 cubic feet per second. This overflow was considerably less than that which occurred during the December 1955 flood when the levees were breached. Consequently, Fresno River flood flow through the City of Madera in January 1969 (about 15,000 cubic feet per second) was considerably greater than in December 1955. However, flooding in January 1969 was minor compared to the February 1969 flooding, which was characterized in newspaper accounts as "five times the waters and ten times the damage" of the January 1969 event (Reference 3).

2.4 Flood Protection Measures

Hidden Lake Dam, completed in September 1976, regulates flood flows in the Fresno River. Under normal operation, the 100-year discharge is low enough that flooding is largely contained in the stream channel. However, for flooding of the 500-year magnitude. Hidden Lake Dam does not provide adequate protection.

A flood barrier at the Cottonwood Creek overflow channel, in the form of a highway embankment, was constructed in approximately 1975. This embankment serves to limit any spills to Cottonwood Creek to the capacity of the 96-inch diameter culvert through the embankment. Such spills cannot exceed a few hundred cubic feet per second even during rare uncontrolled flows from Hidden Reservoir, and thus are not a significant factor in the City of Madera's flood control program.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any

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10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1 and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

The following reports by the Corps of Engineers were reviewed: Floodplain Information Report for Madera, June 1973 (Reference 3), Hydrology Memorandum No. 1 for Hidden Dam, June 1964 (Reference 4), and Reservoir Regulation Manual for Hidden Lake, March 1975, (Reference 5). Data from the documents listed above and unpublished information from the Corps of Engineers were utilized during this study.

Rainfall data were obtained from the California Department of Water Resources (Reference 6) for rainfall gages in the Madera Region. Unit hydrographs were developed for sub-basins using a regional S-curve hydrograph developed by the Corps of Engineers.

Each of the basins was modeled using the rainfall data, the unit hydrographs and the HEC-1 rainfall runoff model developed by the Corps of Engineers (Reference 7). The results were reviewed and peak flow frequency curves were adopted for key points. Table 1 summarizes the peak discharge-drainage area relationships for Fresno River at these key points.

Developed discharges reflect the flood flow reduction that will be afforded by the operation of Hidden Dam on the Fresno River. The regulated discharge values, publishing by the Corps of Engineers in the Reservoir Regulation Manual for Hidden Lake, March 1975 (Reference 5), were adopted for the purposes of this flood insurance study.

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TABLE 1. SUMMARY OF DISCHARGES

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Fresno River					
Madera Canal Crossing	271.3	5,000	5,000	5,000	35,000
Main Canal Diversion Weir	287.9	5,400	5,700	5,800	29,000
Southern Pacific R.R.	290.6	5,400	5,700	5,800	12,500[1]
10,000 Feet Downstream of Highway 99	290.9	5,400	5,800	5,900	11,500

[1] Flood flow discharge in Fresno River reduced due to overland flow occurring above Tozer Street as shown on the Flood Insurance Rate Map.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections for the backwater analyses of all waterways studied were obtained from ground surveys performed in September of 1984 (Reference 8). All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Insurance Rate Map (Exhibit 2).

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgement and based on field observations of the streams and floodplain areas. The roughness value used for the main channel of the Fresno River was 0.040. Roughness values ranged from 0.050 to 0.100 for overbank areas.

Starting water surface elevations on the Fresno River were established by the slope-area method. Water-surface elevations of floods of the selected recurrence intervals were computed through use of the COE HEC-2 step-backwater computer program (Reference 9). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

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The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps; the description of the marks are presented in Elevation Reference Marks (Exhibit 3).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages state and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, with a contour interval of 5 feet (Reference 10).

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zone AE); and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of

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floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated at selected cross sections (Table 2). In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE[3]
					(FEET NGVD)			
Fresno River								
A	3,433	244	1292	4.6	269.7	269.7	269.7	0.0
B	7,298	303	1220	4.8	274.4	274.4	274.8	0.4
C	9,533	218	1603	3.7	277.3	277.3	277.4	0.1

[1] Feet upstream of State Route 99 south bridge.

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MADERA, CA
(MADERA CO.)

FLOODWAY DATA

FRESNO RIVER

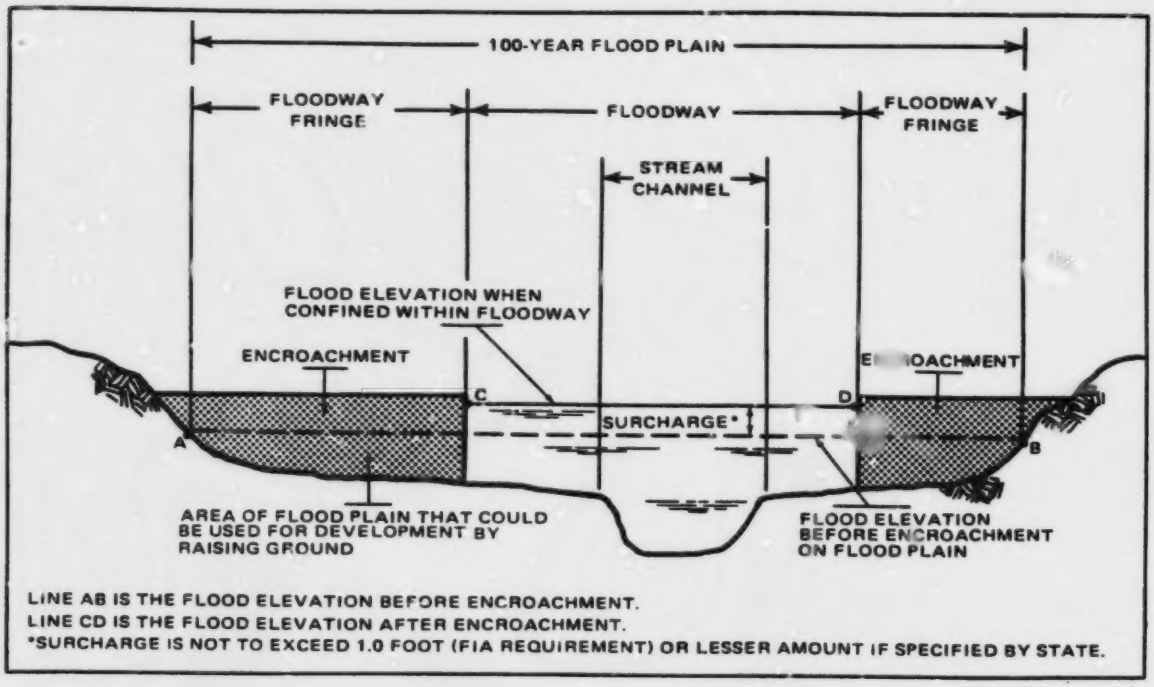
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FIA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Figure 2. Floodway Schematic

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 100- and 500-year floodplains, the floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

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7.0 OTHER STUDIES

There are no other flood insurance studies for communities in the vicinity of Madera.

Due to its more detailed analysis, this Flood Insurance Study supersedes the previously printed Flood Hazard Boundary Map for City of Madera (Reference 11).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Presidio of San Francisco, Building 105, San Francisco, California 94129.

9.0 BIBLIOGRAPHY AND REFERENCES

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7. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, 1973.

8. John T. Seace, Inc., Ground Surveys, September 1984.

9. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water-Surface Profiles, Davis, California, December 1968, with updates.

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EXHIBIT 3 - ELEVATION REFERENCE MARKS
CITY OF MADERA, MADERA COUNTY, CALIFORNIA

Reference Mark	Elevation (feet NGVD)	Description of Location
RM 1	272.257	W-85 USC&GS brass cap on the north wingwall of State Route 99 north bridge over Fresno River 21' NE of centerline of highway.

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10. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 feet: Madera, 1963, Photo Revised 1981.

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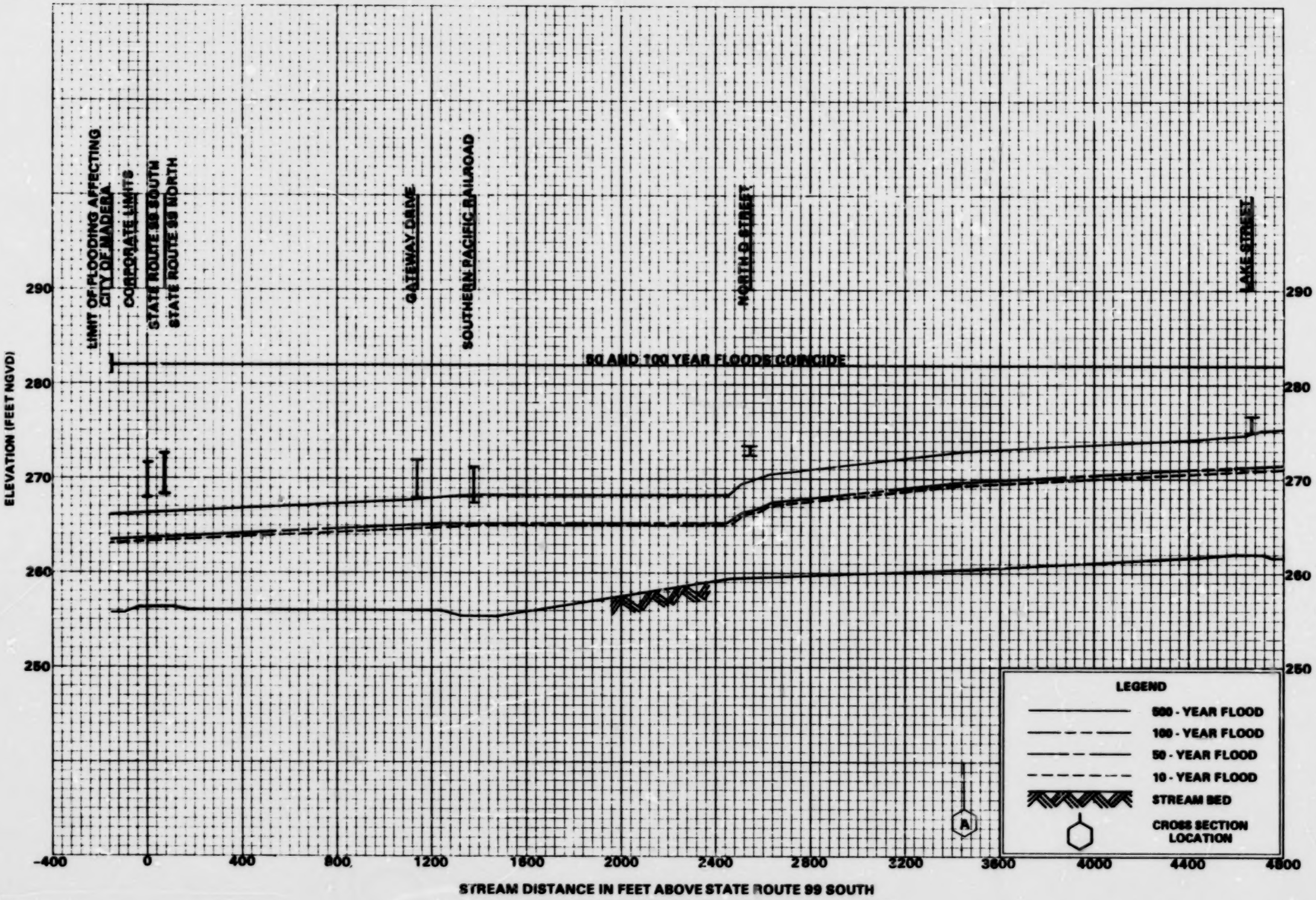

FLOOD PROFILES

FRESNO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MADERA, CA
(MADERA CO.)

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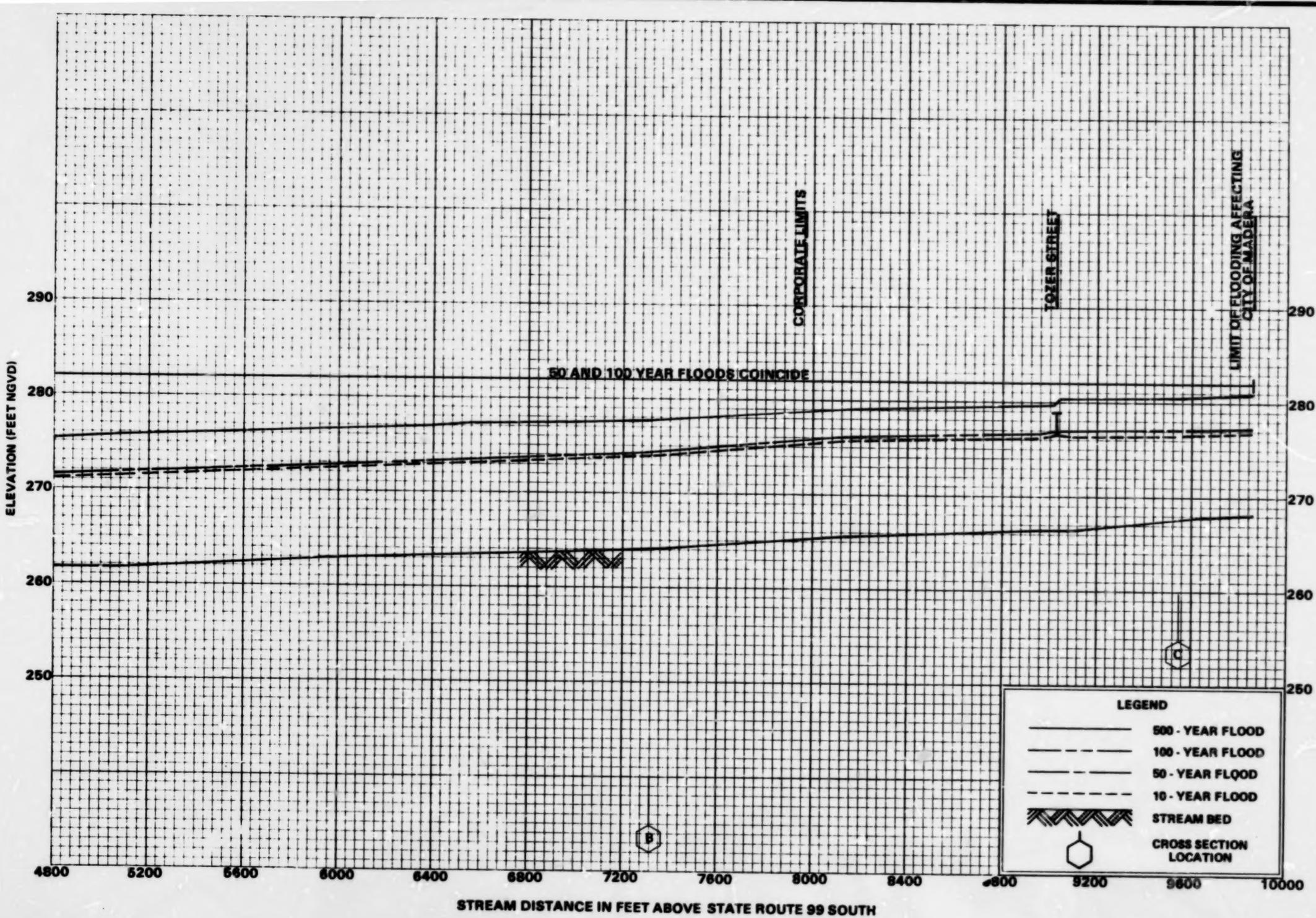

FLOOD PROFILES

FRESNO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MADERA, CA
(MADERA CO)

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